BOX BOTTOM COMPOSITE SACK

FIELD OF THE INVENTION

[0001] The present invention relates generally to composite sacks for packaging of bulk material. More particularly, the present invention relates to composite sacks having a box shaped end.

BACKGROUND OF THE INVENTION

[0002] Sacks are commonly used to pack bulk material for storage or transportation, and have capacities anywhere between 10 to 1000 kilograms for example. These sacks can take on different shapes, such as pillow and box shapes. A pillow shape is typically created by manufacturing the bottoms with seams. A box shape is created by folding and bonding the bottom into a block form. Those of skill in the art will understand that a box shape optimizes use of the material surface, facilitates stacking and provides improved utilization of volume due to its brick shape. A variant of the box shape sack is the quasi-box shape which is a pillow sack on one side and a box sack on the other.

[0003] There is a wide variety of literature regarding box bottomed bags, including the following patents.

[0004] U.S. Patent No. 3,195,801 to Symons et al. discloses a bag formed from heat sealable thermoplastic material. The material is folded to form four side walls and an open rectangle at each end of the tube. At least two of the four edges of each rectangular bottom are heat-sealed along their length to two of the sidewalls. A separate rectangular cover sheet, made of the same thermoplastic material, is then aligned and superimposed upon the open rectangle to provide a sealed bottom. The bag may also provide a single valve located in one of the corners of the bag. The valve is used to facilitate the filling of the bag with granular or pulverulent materials. The bag disclosed in Symons is atypical of box bottomed bags in that most box bottomed bags and sacks are formed from a tube whose open ends are folded to close the end. The closed end is then sealed with a cover sheet. While Symons teaches a means for creating a sack with less material, the simple heat seal typically does not provide structural rigidity. When a filled bag is rotated so that the sealed end is

substantially bearing the load, the heat sealed section of the two fabric pieces must bear all the load, which puts great stress on the seal itself. As a result, the choice to not fold over the ends of a tubular section of fabric results in both a loss of rigidity and a loss of end strength.

[0005] U.S. Patent No. 3,397,622 to Goodwin discloses a bag made of flexible heat-sealable sheet plastic material such as polyethylene. At the top and bottom closures of this bag, a rectangular cover made of the same heat sealable sheet plastic material (e.g. polyethylene) is applied. Strips of heat seal inhibiting material are attached at two edges of these ends of these covers so that they may attach to the bag closures. The top closure of the bag also contains a valve flap which is used for filling purposes. The bag is completed by folding over the top and bottom side flaps and creating heat seals where the flaps overlap. Polyethylene is not typically used in oriented fabrics and thus does not typically provide the strength required for heavy loads.

[0006] U.S. Patent No. 3,448,666 to Kappelhoff discloses a cross bottom sack with a tube length made of thermoplastic material, preferably of polyolefins. The open ends of the tube are pre-treated with coatings of an adhesive, which is effective in a dry, or almost dry condition. After the treatment, the tube end portions are folded along the intended fold lines to form open crossed tops and bottoms with infolded corner portions. To close the top and bottom portions, the side flaps are folded over towards the middle and are adhered to by the adhesive coated surfaces. The bottom portion is completed by attaching a bottom covering sheet, which has been pre-treated and provided with the adhesive layer. The use of adhesives limits this bag and its applications. As previously mentioned, in many fields the materials stored in the bags are provided at a temperature that causes the adhesive to liquefy, and the adhered bond to be dissolved. As a result, the application of an adhesive makes the bag unusable in applications where the contents for storage are provided at high temperatures.

[0007] U.S. Patent No. 3,660,150 to Cooper discloses both a coated woven material and a method for producing the coated woven material. Cooper teaches the a laminated web consisting of a woven layer and a continuous thermoplastic coating, and discloses the use of this material in bags and sacks, such as the bags and sacks taught in the other references. Cooper is directed to the actual coated woven fabric, and not to the construction of the sacks per se.

[0008] U.S. Patent No. 3,736,219 to McTaggart discloses an apparatus that provides a strong, flexible, heat resistant seal for uncoated oriented polyethylene terephthalate film. The seal is created by first superposing polyethylene terephthalate films and cutting off a portion of the two films to provide uniform congruent edges. The films are then passed over a heat sink whereby the edges of the two films become fused thus forming a heat seal. Finally, the heat sealed film is then passed over a cooling station. At this stage, the heat sealed film can either be wound up on a roll or alternatively folded, trimmed and sealed to form a tube. Though McTaggart does teach the sealing of an oriented polyethylene film, the resulting sealed film cannot be used in the production of sacks and bags that are used to contain heavy loads, as the oriented film is insufficiently strong.

[0009] U.S. Patent No. 4,270,677 to Schmidt discloses a reclosable cross-bottom sack. The sack consists of a square base with two side flaps. When the side flaps are folded onto the base, their end faces are spaced from each other forming a channel. Within this channel is an internal lock where a base cover sheet along with a base closure lock can be applied. This results in the base closure lock bridging the space left vacant by the base side flaps. The base cover sheet is attached by means of a two component adhesive. To open the sack, the closure lock is pushed into a position in which its hole is disposed substantially near the middle of the base. At this point, a corresponding hole in both the cover sheet and the internal lock is made to let out the contents of the bag. In order to close the hole, the closure lock is pulled away so that its hole leaves the vicinity of the pierced holes. As earlier described, the use of an adhesive limits the applications for which the sack can be used.

[0010] U.S. Patent No. 4,235,366 to Achelpohl et al. discloses a plastic sack made from a coated tube of woven tape. The tube when opened, forms a square base outlined by two triangular corner tucks. An internal closure member is welded to the edges of the corner tucks by weld seams. The base is closed by folding two side flaps one at a time. The first side flap is folded onto the tube's base. Afterwards, a base cover sheet with releasable adhesive in its interior is then applied over the base. Finally, the second side flap is folded on top of the base cover sheet and secured by dabs or strips of glue. A weld seam is also applied to close the end of this base side flap. The sack taught by Achelpohl et at. is clearly directed to the use of laminated drawn plastic tapes to form both the sack and the coversheet.

[0011] U.S. Patent No. 4,284,229 to Schmidt et al. discloses a reclosable cross bottom sack with a tube section of plastic material or plastic tape fabric. The closed cross bottom is formed by folding and adhering the side flaps of the tube section. The base cover sheet is also made of plastic material or plastic tape fabric and is laminated or adhered to a film of plastic material on the base. A central slit in the cover sheet is provided to connect the sack to a separate side tube. This is accomplished by pushing the ends of the side tube through the slit until these ends lie flat on the inside of the base. The side tube is also connected to the base cover sheet by means of weld seams. The purpose of this side tube is to provide a means of partially or completely emptying the contents of the sack. Additionally, Schmidt et al. discloses the use of an inner sack of plastic film used to allow opening and closing of the sack for partial filling or emptying. However, Schmidt et al. is also clearly directed to the use of laminated drawn plastic tapes to form both the sack and the coversheet.

[0012] U.S. Patent No. 3,979,049 to Achelpohl discloses a closed cross bottom bag. The bottom end consists of two side fold portions, a square base portion and two triangular corner tucks. To completely close the bottom end, a strip of hot melt material is first applied to the corner tucks. This is followed by folding the two side fold portions over onto the square base portion. Finally, a cover sheet with strips of hot melt material at the edges is adhesively secure to the tucked and folded portions of the bottom. This is achieved by aligning the strips of hot melt material on the cover sheet with those on the corner tucks so that the exposed part of the coatings come into contact. As described above, the use of an adhesive, such as that described in Achelpohl et al., typically provides a seal that is insufficiently strong for use in hot fill environments. Additionally, Achelpohl et al. teaches the use of tape based fabrics for both the coversheet and the sack body.

[0013] As shown above, it is known in the art to coat materials, such as monoaxially oriented drawn tape woven fabrics as well as natural fabrics, to produce a material that is both strong and impermeable. One technique for laminating such a material is disclosed in Canadian Patent No. 1,133,369 to Stead et al. Stead et al. teaches the lamination of knitted, woven or folded fibres of cotton, wool, glass, polypropylene, nylon, polyethylene terephthalate, polyacrylate or mixtures of two or more such fibres. Melded cloth such as Cambrelle is also suitable for the process described by Stead et al. In one of the procedures,

a web of unfilled polypropylene is sandwiched between a sheet of filled polypropylene composition and a cloth. While being sandwiched, the heat from the filled polypropylene causes the boundary between the sheet and the web to become insignificant. As a result, on cooling, the laminate is formed.

[0014] As described above, sacks are commonly manufactured with plastic fabrics consisting of monoaxially drawn tapes. The tapes are typically polypropylene tapes. Drawn tapes have high strength in one dimension due to the aligned orientation of its molecular chains resulting from the drawing process. A fabric is woven from weft and warp tape "threads". This fabric has high load bearing strength and two dimensional stability resulting from the perpendicular warp and weft tapes. To prevent seepage of the contents of the bag, the fabric is sealed, typically using a polyethylene laminate. The folded bottom of box shaped sacks preferably use a cover sheet of the same material as the sack that is thermally bonded to it for providing mechanical strength and durability.

[0015] Cover sheets are used so that additional strength is provided at the ends of the bag so that the box bottom folding does not become undone in shipping. The coversheets must be bonded in such as way that they both provide strength and at the same time must be economical. Though one option for adhering the coversheet is the use of adhesive compounds such as glue, it has been found that the warm packing of cement, a common content for box bottomed tape fabric sacks, introduces the cement at a temperature that melts the glue, and results in the weakening of the coversheet bond. As a result, gluing of a coversheet is not considered feasible, and the thermal attachment of a tape fabric cover sheet is employed. Adhesives that do not melt in this temperature range are typically considered to be too expensive to be cost effective.

[0016] U.S. Patent 5,845,995 to Starlinger Huemer discloses a box bottomed bag made of a monoaxially oriented drawn tape woven fabric that has coversheets, of an identical material, heat fused to the sack body. Although Starlinger Huemer teaches the controlled heating and pressing of the sack body and coversheet to minimise the amount of disorienting that occurs as a result of the application of heat in the sealing process, an analogous technique is used for other applications of woven tape fabrics, such as in the manufacture of synthetic tarpaulins.

[0017] In the adhering process, a coversheet made of coated tape fabric similar or identical to the fabric of the sack is attached to the bag using a heat and pressure process to fuse the coversheet to the sack. In the heating process, the polyethylene coating of the bag and coversheet melt and bond. Additionally, the small amount of polyethylene in the fabric is drawn to the surface allowing the sack and the coversheet to be securely bonded. If done carefully, the heat and pressures used in the process will be above the threshold at which polyethylene melts, but below the threshold at which polypropylene melts. This prevents holes from developing in the sack or the coversheet.

[0018] Unfortunately, the plastic fabric tapes are susceptible to heat in a manner unrelated to causing holes. A heating process is used during the drawing of the fabric tape to obtain the monoaxial orientation of the polymer chains that provides strength. During the heating process to adhere the coversheet the monoaxial orientation of the molecular chains in the tapes can be lost, resulting in loss of fabric strength. The thermal bonding process thus requires precise control over parameters such as heating temperature, heating time and pressure for the specific thickness of the fabric tape to minimize molecular disorientation. Unless specific equipment is used, unreliable bonds can be formed and defective sacks will be manufactured therefrom. Starlinger teaches the use of costly equipment for the reliable adhering of coversheets. Additionally, the monitoring and control systems required are relatively expensive and technically complex. Further adding to the cost of manufacturing plastic fabric tape sacks is the equipment required for manufacturing the plastic tapes.

[0019] Alternate methods of attaching the coversheet have typically been viewed as undesirable. As discussed above, gluing the coversheet is unsuitable in cases where the sacks are to be warm filled, as the adhesives used in this process tend to dissolve at the produced temperatures. Though advanced adhesives can be used, they are typically more expensive, and are thus considered relatively undesirable. Stitching a laminated coversheet to a laminated fabric sack will adhere the coversheet with sufficient strength,but the stitching perforates the sack and thus reduces the impermeability of the sack achieved through lamination. Though the stitches can be covered by an adhesive tape, this introduces another expense which is undesirable.

[0020] While plastic tapes are a suitable material for sacks, they are not abundantly available in certain parts of the world, especially in third world countries where industrial

development drives the need for large amounts of inexpensive high volume packaging. Although paper is an alternative material to plastic, trees required to make paper can be scarce and their use in the manufacture of paper is environmentally detrimental. The highly automated processing required to produce reliable box bottom sacks made from monoaxially oriented tape fabrics, is considered cost effective in some parts of the world, but in many parts of the world, the material costs are considered to be high, as are both the cost of the machinery, and the cost of a reliable power supply required to keep the process operating efficiently.

[0021] In the interests of reducing costs, taking advantage of local variations in the costs of materials and labour, sacks are ideally manufacturable with a readily abundant material, and with low cost equipment and methods. The use of a fabric that is not as susceptible to loss of strength due to heat sealing as polypropylene tape fabrics are would also be beneficial. Thus, it would be desirable to provide a box bottomed sack or bag that can be created without strict reliance on the use of laminated woven tape fabric, requiring difficult to implement coversheet attachment.

[0022] It is, therefore, desirable to provide a box bottomed sack or bag that can be created at a lower cost and in greater harmony with concepts of appropriate technology and environment friendliness by taking advantage of regional differences in the above factors.

SUMMARY OF THE INVENTION

[0023] It is an object of the present invention to obviate or mitigate at least one disadvantage of previous box bottomed sacks. In particular, it is an object of the present invention to provide a box bottomed sack that minimises the reliance on materials that are scarce, difficult to produce, difficult to work with and environmentally unfriendly.

[0024] In a first aspect of the present invention, there is provided a box bottomed sack. The sack comprises a sack body and a cover sheet. The body has one end folded into a box bottom configuration, preferably including a self closing valve, and is constructed from a material selected from a list including a monoaxially oriented woven tape fabric, fabrics made from cotton, jute, hemp, nylon and polyester. The cover sheet is attached to the folded end of the sack body, and is constructed from a material selected from a list including a monoaxially oriented woven tape fabric and fabrics made from cotton, jute, hemp, nylon,

polyester and non woven, paper, film and foil. The material selected so that exactly one of the sack body and cover sheet are constructed from a monoaxially oriented woven tape fabric.

[0025] In an embodiment, the sack further includes a liner, that is optionally micro perforated, and is attached to the sack body by preferably stitching and is larger than the sack body in at least 1 dimension. In this embodiment, the folded end of the sack body includes a self closing valve that opens to the interior of the liner. In another embodiment, the liner is affixed to the sack prior to folding the edges.

[0026] In another embodiment, the cover sheet is attached to the sack body by an attachment method selected from a list including gluing, sewing, tacking, taping and slit die extrusion.

[0027] In a further embodiment, either one or both the sack body and the cover sheet are laminated by a thermoplastic material selected from a list including polyethylene, polypropylene, polyolefins, and ethylene vinyl acetate. In this further embodiment, the cover sheet is preferably attached to the sack body by fusing the lamination of the sack body and the cover sheet by an method selected from a list including heat sealing, ultrasonic plastic welding, heating plate pressing, heat plate pinning and friction welding.

[0028] In another embodiment, the sack body has both its ends folded into a box bottom configuration, and the sack further includes a second cover sheet that is attached to the second folded end of the sack body, the second cover sheet selected from a list including a monoaxially oriented woven tape fabric and fabrics of cotton, jute, hemp, nylon and non woven, paper, film and foil.

[0029] Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] Embodiments of the present invention will now be described, by way of example only, with reference to the attached Figures, wherein:

Figure 1 is an orthogonal view of a box bottom sack according to an embodiment of the present invention;

Figure 2 is an orthogonal view of the box bottom sack of Figure 1 showing a valve location in the box bottom sack of Figure 1;

Figure 3 is an orthogonal view of a length of fabric and liner used to manufacture the box bottom sack of Figures 1 and 2;

Figure 4 is an orthogonal view of the length of fabric of Figure 3 with the liner stitched to the fabric;

Figure 5A is a plan view of the fabric of Figure 3, with an unsealed liner, in a partially folded state;

Figure 5B is a plan view of the fabric of Figure 3, with a sealed liner, in a partially folded state;

Figure 5C is a plan view of the fabric of Figure 3, without a liner, in a partially folded state;

Figure 6A is a plan view of the partially folded fabric of Figure 5A with a valve;

Figure 6B is a plan view of the partially folded fabric of Figure 5B with a valve;

Figure 6C is a plan view of the partially folded fabric of Figure 5C with a valve;

Figure 7A is a plan view of the fabric of Figure 6C in a subsequent folded state

Figure 7B is a plan view of the fabric of either of Figures 6A or 6B in a subsequent folded state;

Figure 8 is an end view of the fabric of Figure 7 in a completed folded box bottom configuration; and,

Figures 9-12 illustrate methods of bonding a cover sheet to the sack.

DETAILED DESCRIPTION

[0031] The present invention provides for a box bottomed sack or bag that can be manufactured without complete reliance on coated woven tape fabric. As discussed above, this fabric is typically selected for its strength and its ability to prevent the seepage of its contents. There are a range of other woven fabrics made of non-oriented fibres that can be used, and are more readily accessible in many parts of the world. These fabrics include cotton, hemp, jute, other commonly used natural fibres as well as synthetic fibres such as nylon and polyester. These fabrics can be manufactured locally in many parts of the world where labour costs are lower, and then used to form the body of the bag. To prevent

seepage, these fabrics can be coated on either a single side, or both sides, with a thermoplastic material such as polyethylene, polypropylene, E.V.A. to seal the sack and to facilitate bonding to the cover sheet. The cover sheet can also be constructed with any suitable material, such as those listed above, and attached to the folded box bottom of the sack by a corresponding method for the specific cover sheet material. The cover sheet can be coated with thermoplastic material to facilitate bonding to the sack. The box bottomed sack constructed using natural fibres does not require costly equipment to manufacture, and is less susceptible to weakening due to heat treatment and is friendlier to environment.

[0032] It is however generally acknowledged that the use of woven oriented tape fabric has advantages. In contrast to many natural fibres, oriented tape fabric has a low weight to strength ratio, which is desirable. It has been found, that a mixing of materials provides some of the benefits of both fabrics. By building the sack body from woven tapes, and a coversheet from a natural fibre fabric, the overall sack weight is kept low,but the ends of the bag have increased flexibility, which helps with the handling of the bags. Additionally, as the cost of the materials fluctuate, costs can be lowered by changing from a woven tape sack body and natural fibre fabric coversheet, to a woven tape coversheet and a natural fibre fabric sack. One skilled in the art will appreciate that synthetic fabrics such as polyester and nylon can be used in place of the natural fibre fabric to bond to the oriented tape fabric while providing many of the same benefits.

[0033] Thus, the creation of a box bottomed sack where one of the sack and coversheet are made from woven monoaxially oriented tapes, while the other is made of a non-oriented fibre fabric can provide a mixture of benefits, and can allow for cost based variation.

[0034] As in prior art implementations, coversheets can be adhered to the sack body using by bonding the elements using heat and pressure. By proper coating of the non-oriented fabric, a simpler process, with a larger margin of error is possible. This allows the process to be performed either by a machine or manually, so that in markets with low labour costs the sacks can be assembled by handheld tools.

[0035] In another embodiment of the present invention, seepage is prevented without the lamination of the sack body and coversheet. If both the sack body is left unlaminated, it will not be able to prevent the seepage of its contents during shipping, handling and under

other forms of pressure and stress. The limiting factor for this process is the size of the pores created in the weave of the fabric. For large size granules, such as rice grains, tapioca beads and other food stuffs, it is possible to simply provide a tight weave in an unsealed fabric so that the contents cannot seep. For smaller grain contents, such as powders, a seal cannot be introduced by simply creating a tighter weave. While previous attempts at preventing the seepage of powders such as cement have focussed on sealing the fabric used to create the sack through lamination, one embodiment of the present invention addresses the issue by introducing a sack liner. Those skilled in the art will appreciate that liners can easily be created with small pores, commonly referred to as micro-pores, at a low cost, so long as the liner is not overly strong. This has traditionally been viewed as a detriment as a weak liner will tear under the pressure of a large load. However, if the liner is larger than the an unsealed sack, in at least one dimension, the liner can be used to prevent seepage, and the unsealed sack can be used to provide the load bearing strength without needing to prevent seepage. One skilled in the art will appreciate that the thickness of the liner can be varied, but is typically on the order of 5 to 100 μm.

[0036] It will be apparent to those familiar with present box bottomed sacks that they are typically designed to be self closing, and are filled through a valve in their top fold. The valve typically has a flap that, under the pressure of the contents, closes to prevent the contents from leaking. To attach a liner, prior to the folding of the box edge and the attachment of the self sealing flap, a liner can be sewn into the fabric so that it is held in place during loading. If the top of the sack is to be a box form, the liner is attached prior to the folding of the end of the sack. As the loading of fine particulate matter is typically done through a mix of gravity and blowing, in a presently preferred embodiment, the liner has vents to allow for the escape of the forced air. Though it is acknowledged that the contents of a loaded sack may escape through these vents, it is also recognised that the contents then have to work their way through the load bearing sack. This double barrier provides sufficient protection from seepage to meet requirements of most applications.

[0037] The present invention provides two methods of attaching a liner to the interior of the sack. In the first embodiment, the liner used is larger than the sack in at least one dimension, so that the load of the contents is borne by the sack, and the liner need not be overly strong. In this embodiment, the liner has both an open and a closed end, and the

closed end is inserted into the sack body, either before or after the end of the body has been closed. The open end of the liner is then affixed to the sack body, and the end of the sack body is folded into form. Preferably, the end at which the liner is affixed is provided with a self closing valve. In an alternate embodiment, neither end of the liner is closed. Instead, the liner is inserted into the sack body before either end is sealed. The liner is affixed to the sack body, and the ends of the sack body are then folded closed. In this manner, the sack is provided with a liner along its full length.

[0038] An alternate method of attaching the coversheet to the sack is now described. If the sack body is unlaminated, and a laminated coversheet is used, a heat sealing process can be implemented as before, and if sufficient lamination is present on the coversheet, it will impregnate the sack body and seal the two together. The same is true if the sack body is laminated but the coversheet is not. In instances where neither the coversheet nor the sack body are laminated, they can be stitched, glued, tacked or bonded through slit die extrusion.

[0039] Thus, the present invention provides for a box bottomed sack that seals the contents either through a tight weave, through a liner bag, or through coating of the fabric of the sack. The sack itself can be created from fabrics available in a local environment and does not require expensive manufactured monoaxially oriented tapes. In the following description, the design of the above described sacks is presented, and one skilled in the art will appreciate that the manufacture of these sacks can be automated, but can also be performed through the use of local labour when labour costs make this an attractive option. The sealing of woven tape fabrics to other woven tape fabrics is known in a number of arts, including that of synthetic tarpaulin manufacture, and is applicable to the present invention.

[0040] As should be known to those of skill in the art, a box bottom sack.is generally constructed with a seamless tubular fabric or flat fabric combined to form a tube, where at least one end of the sack has its ends folded to form a rectangular bottom surface.

[0041] Figures 1 and 2 are drawings of a box bottomed sack according to embodiments of the present invention. In Figure 1, sack **100** includes a sack body **102**, a box bottom end **104** and a top end **106**. Box bottom end **104** can be folded by any known method known to those of skill in the art, and a cover sheet **108** is attached to box bottom end **104** to secure the folds. While the top end **106** is shown in a box, or block configuration, top end **106** can be configured in a pillow shape, or any desired configuration. According to an

embodiment of the present invention, sack body **102** is constructed from a fabric such as cotton, hemp, jute, or from a woven tape fabric, while cover sheet **108** is constructed from a fabric selected from the same list, which may optionally be augmented by the inclusion of paper, films and foils, but selected so that cover sheet **108** and sack body **102** are not both made from a coated monoaxially oriented woven tape fabric. Preferably, one of the sack body **102** and the coversheet **108** are monoaxially oriented woven tape fabrics. Many different methods can be used to attach cover sheet **108** to sack body **102**. For example, a natural fibre fabric cover sheet **108** can be stitched, tacked or clipped, or bonded through slit die extrusion or if cover sheet **108** and sack body **102** are both coated to prevent seepage, they can be heat sealed so that the sealing compound that permeates both fabric pieces adheres to form a bond.

[0042] According to one embodiment, a low cost natural fibre fabric sack body **102** can be manufactured because it is not coated with a laminate material to seal it. Alternatively, the natural fibre fabric sack **100** can have its external surface laminated, its internal surface laminated, or both the internal and external surfaces laminated. The laminate material can be any suitable thermoplastic material, such as polyolefins like polyethylene and polypropylene as well as other known coatings such as ethylene vinyl acetate (EVA) and copolymers. These coatings, when coated onto sack body **102**, prevent fine particulate matter from seeping. While a cover sheet **108** can be attached to the sack body **102** by the previously described attachment methods, the cover sheet **108** can be laminated with the thermoplastic material and attached to the laminated or unlaminated box bottom **104** by appropriate attachment means such as heat sealing, ultrasonic plastic welding, pressed means such as a heating plate or pin, or friction welding for example. Of course, stitching, clipping, and tacking methods can be used to attach the laminated cover sheet **108** to sack body **102**. In an alternate embodiment, cover sheet **108** can be constructed with a plastic material laminated with thermoplastic material, and then attached to sack body **102** with the previously mentioned techniques.

[0043] Figure 2 shows the features of box bottom **104** illustrated by dashed lines, that are hidden by cover sheet **108**. Box bottom **104** preferably includes a valve **110** disposed over folded side flap **112**, and a top flap **114** folded over valve **110**. Finally, a bottom flap **116** is folded over top flap **114**. Valve **110** permits insertion of a pipe into the interior of sack body

102 while the sack **100** is empty for delivery of material, while effectively preventing seepage or escape of material once the sack **100** is full and the box bottom **104** is placed on a surface. The weight of the material will press valve **110** upon the top and bottom flaps **114** and **116** to close valve **110** when sack **100** is filled.

[0044] Another method of sealing sack **100** is to incorporate a liner into the interior surface of sack **100**. Liners are well known in the art, and can be any material to suit the material being packaged.

[0045] Figure 3 is a drawing of a sack body **102** and a liner **120** prior to assembly. Preferably, liner **120** is a thin plastic material and shaped to be larger in volume than the sack body **102**. The larger liner size ensures that the load of the material is supported by the sack body **102**, since the liner **120** is relatively weak in comparison to the material of sack body **102**. The liner **120** can be sealed at the edge **122** to prevent the packaged material from escaping.

[0046] As described above, the liner **120** can also be inserted into the sack body **102**, with no closed end, and affixed to both ends of the sack body **102** prior to folding. The sack body **102** , with liner 120 affixed can then be folded and sealed in the desired manner to form a sack **100** with an affixed liner.

[0047] Figure 4 is a drawing of liner **120** attached to the interior surface of sack body **102**. After the liner **120** is inserted into the interior of sack body **102**, the liner is hemmed with stitches **124** near the periphery of sack body **102**, except at the end where the liner **120** protrudes from sack body **102**. Although the liner **120** is shown attached to sack body **102** with stitches **124**, liner **120** can be sealed, glued, heat sealed or clipped to sack body **102**. In a presently preferred embodiment, bulk material can then be used to fill the sack**100** through its filling vent. In an alternate embodiment, liner **120** is attached to sack body **102** as described above. The top of sack body **102** is not closed, so the bulk material can fill the sack **100** through the un-hemmed edge of sack body **102** and liner **120**. Once liner **120** is filled, sack **100** can be closed to form a box bottomed end. This configuration removes the requirement for a valve.

[0048] Figures 5 to 10 illustrate the steps for folding the end of sack body **102** of Figure 4 into a box bottom configuration.

[0049] Figures 5A, 5B and 5C show the flat sack body **102** of Figure 4 in a partially folded state where an open end of sack body **102** has its side flaps **112** folded towards each other to expose the interior surface **130** of sack body **102** and optionally liner **120**. As previously shown in Figure 4, liner **120** is attached to sack body **102** via stitches **124**. In particular Figure 5A shows the embodiment where sack **100** has an unsealed liner **120** that is affixed to the sack body **102**. The liner as illustrated in Figure 5A is unsealed, and the subsequent folding of the sack will provide a folded over liner end, so that the bulk material will be substantially prevent from seeping. In Figure 5B, the embodiment of a sealed sack liner is illustrated. The liner **120** is inserted into sack body **102** as before, but the bottom end is sealed at edge **122** to prevent seepage of the packaged bulk material. Figure 5C illustrates the embodiment where no sack liner is used.

[0050] Figures 6A, 6B and 6C show the partially folded state of sack body **102** of Figure 5 after attachment of valve **110**. Valve **110** is a sheet of material that is placed over one of side flaps **112**, after the side flaps **112** have been folded towards each other. Valve **110** can be formed in any shape and in any desired size. Figure 6 further shows the top and bottom flap fold lines **132** whereby the top and bottom flaps are folded towards each other in a subsequent folding step. Figure 6A illustrates the partially folded state of sack body **102** with the unsealed liner, as shown in Figure 5A. Figure 6B illustrates the partially folded state of sack body **102** with the sealed liner, as shown in Figure 5B. Figure 6C illustrates the partially folded state of sack body **102** without a liner, as shown in Figure 5C.

[0051] Figures 7A and 7B show sack body **102** after the top flap **114** and the bottom flap **116** are folded towards each other along the top and bottom flap fold lines **132**. It is noted that valve **110** is also folded along the same fold lines **132** as top flap **114** and bottom flap **116**. Preferably, one of the flaps is folded to overlap the other flap as shown in Figure 7. It should be obvious to those of skill in the art that the position of fold lines **132** can be selected to determine the amount of overlap between the top flap **114** and bottom flap **116**. After top flap **114** and bottom flap **116** are folded, sack body **102** is folded along side edges **134** to complete the box bottom configuration of sack **100**. Figure 7A illustrates sack body **102** without a liner, while Figure 7B illustrates sack body **102** with liner **120**

[0052] Figure 8 shows the box bottom **104** of sack body **102** after cover sheet **108** is attached to cover side flaps **112**, top flap **114** and bottom flap **116**. As previously mentioned,

cover sheet **108** can be glued, stitched, or clipped to box bottom **104** if unlaminated, or can be attached through heat sealing, ultrasonic plastic welding, pressed heating plate or pin, or friction welding to box bottom **104** if cover sheet **108** is laminated.

[0053] Figures 9 through 12 illustrate methods for attaching cover sheet **108** to box bottom **104** according to embodiments of the present invention. More specifically, the methods use rollers to press the cover sheet **108** to box bottom **104** as heat is applied to the surfaces to be bonded.

[0054] In Figure 9, a cover sheet **108** laminated with thermoplastic material **140** and a box bottom **104** laminated with the same or different thermoplastic material **140**, are rolled between a pair of rollers **142** as heat **144** is applied to the lamination material **140**. The cover sheet **108** and the box bottom **104** are drawn in the direction of arrow **146** at a predetermined rate. The heat sufficiently melts the thermoplastic material **140** and the rollers **142** press the cover sheet **108** and the box bottom **104** together to form an intimate bond. The rollers can be cooled to accelerate the bonding process.

[0055] In Figure 10, a cover sheet **108** laminated with thermoplastic material **140** and an unlaminated box bottom **104**, are rolled between a pair of rollers **142** as heat **144** is applied to the lamination material **140** of cover sheet **108**. The melted thermoplastic material **140** will bond to the box bottom **104** as it is drawn and pressed between rollers **142**. Alternatively, the box bottom **104** can be laminated while the cover sheet **108** is unlaminated.

[0056] In Figure 11, an unlaminated plastic cover sheet **108** and an unlaminated plastic fibre fabric box bottom **104**, are rolled between a pair of rollers **142** as heat **144** is applied to the material. The heat is sufficient to melt some of the plastic material of the cover sheet **108** and the box bottom **104** such that they will bond together as they are drawn and pressed between rollers 142.

[0057] In Figure 12, an unlaminated plastic coversheet **108** and an unlaminated box bottom **104**, are rolled between a pair of rollers 142. The lamination material **140** is extruded through a slit die between coversheet **108** and box bottom **104**. The pressure exerted by rollers **142** and the heat that is applied is sufficient to melt lamination material **140** so that it permeates both coversheet **108** and box bottom **104** and secures them to each other.

[0058] It is noted that the material of the cover sheet **108** and the sack body box bottom **104** shown in Figures 9 through 12 can be a natural fibre fabric or plastic material, where any combination of cover sheet material and sack body material is possible.

[0059] Since natural fibres are readily available in many developing countries, box bottomed sacks constructed of natural fibres fabric will have a low material cost in some countries when compared to sacks constructed with less abundant materials, such as plastics. Natural fibre fabric sacks can withstand higher temperatures than plastics, and therefore do not require expensive equipment to monitor and control the cover sheet to box bottom bonding process. Natural fibre fabric sacks are suitable for packaging of cement or other materials since the trapped air flows out of the sack after the filling operation. Laminated sacks can be micro perforated if desired. Furthermore, cover sheets are small in area and do not consume much material, hence they can be constructed of plastic to provide additional strength to the box bottom when attached. The natural fibre sack body can be laminated to seal the sack, or the cover sheet can be laminated. The lamination of either or both the sack body and the cover sheet is further advantageous because it facilitates heat bonding between the cover sheet and the box bottom of the sack. Where a sack liner is to be used, lamination is not essential, as the coversheet can be stitched, or otherwise similarly affixed, to the sack body.

[0060] The above-described embodiments of the present invention are intended to be examples only. Alterations, modifications and variations may be effected to the particular embodiments by those of skill in the art without departing from the scope of the invention, which is defined solely by the claims appended hereto.